Whillans, J., & Nazroo, J. (2014). Assessment of visual impairment: The relationship between self-reported vision and 'gold-standard' measured visual acuity. *British Journal of Visual Impairment*, *32*(3), 236-248. https://doi.org/10.1177/0264619614543532

Peer reviewed version

Assessment of visual impairment: The relationship between self-reported vision and 'gold-standard' measured visual acuity.

ABSTRACT

Self-report assessments of health are commonly favoured indicators used in large scale nationally representative surveys as they can be readily and cost-effectively collected from large numbers of people; however, subjective assessments have been criticised. Using data from the Irish Longitudinal Study on Ageing (TILDA), this article examines the relationship between self-reported vision and measured visual acuity (logMAR). The analysis indicates that normal vision is well captured by a subjective response but there is a slight over-identification of visual impairment using self-reported vision. These findings are discussed in relation to social patterning of mis-reporting. Given the simplicity of the self-report assessment to administer and the correspondence between this and measured visual acuity, it is argued to be a suitable indicator of visual impairment in older people.

Key words: Logarithm of the Minimal Angle of Resolution (logMAR), older people, subjective measures of health, validation study, vision loss.

INTRODUCTION

Older people account for the majority of those in poor health, which would suggest a particularly compelling need to investigate inequalities in health in later life and any underlying causal mechanisms (Grundy & Holt, 2001; Grundy & Sloggett, 2003). The challenges and costs associated with assessing the health of the older population drives the search for indicators of health status and medical conditions that can be readily collected from large numbers of individuals. Direct measures are the gold standard in assessing health, but due to the higher costs of carrying out assessments (including time, money, interviewer/nurse training, and logistics), self-report assessments of health are commonly favoured in large scale nationally representative surveys. However, subjective assessments have been criticised, making it prudent to assess how self-report measures relate to direct measures or diagnoses.

An important personal and public health concern in older age is vision loss: it is reported to be the leading cause of age-related disability with an estimated 1 in 6 people in the over 50s population reporting visual impairment (International Federation on Ageing, 2013; Zimdars, Nazroo, & Gjonça, 2012). Self-report assessments of visual function have been included in a number of nationally representative surveys on ageing. To assess general and/or distance and close visual function respondents are asked to rate their vision, using glasses or corrective lenses as usual, as excellent, very good, good, fair, or poor (or a similar scale). There are a number of potential validity problems with this indicator, as with any self-report assessment, as responses reflect more than measured visual acuity (VA); for example, responses are susceptible to distorted response style (e.g. extreme or central tendency responding) and also to socially desirable responding, whether consciously or unconsciously (Razavi, 2001). Zimdars et al. (2012) present limited analyses showing the relationship between self-reported vision and measured VA; analysis indicated a significant, but not perfect association between the two – almost all of those classified as not having visual impairment were correctly identified, with some over identification of those with visual impairment – suggesting that the self-report assessment had reasonable validity. However, Zimdars et al. (2012) did not directly examine the relationship between measured and subjective assessment of vision and how this was socially patterned.

Using rare matched information from interviews and health assessments from the Irish Longitudinal Study on Ageing (TILDA), this paper will, first, estimate the probability of self-reported and measured visual impairment in relation to socioeconomic variables and health conditions and behaviours; second, examine the accuracy of self-report assessment in identifying measured visual impairment using diagnostic test statistics; finally, analyse the effect of socioeconomic and health variables on (mis)reporting (i.e. true positives, true negatives, false positives, and false negatives) using multinomial logistic regression, to identify social patterning in discrepancies between measures. While direct measures are not entirely free from measurement error (e.g. incorrect testing procedure, inaccurate equipment, or scoring), it is unlikely that errors will be correlated with socio-economic characteristics therefore discrepancies between subjective and measured assessments may be attributable to socio-demographic variations in self-reported vision. The implications of relying on self-reported vision are then discussed in relation to the model results.

METHODS

The Irish Longitudinal Study on Ageing (TILDA) is a large-scale, nationally representative study of people aged 50 and over in Ireland. The first wave of data was released in 2012 with subsequent data releases due at 2-year intervals, currently limiting the study to cross-sectional analyses. TILDA was designed to maximise comparability with other well-established international longitudinal studies. TILDA recruited a stratified clustered sample of 8178 individuals from 6282 households (Savva, 2011). Each participant had a face-to-face interview, completed a questionnaire, and was invited to a health assessment carried out by trained research nurses either at a dedicated centre or in the home. Interviews were conducted between October 2009 and February 2011.

Assessment of vision

TILDA provides contemporaneous and directly comparable, self-reported and measured assessments of visual function. For the self-report assessment of overall vision, respondents were asked the following question and offered the following reply alternatives: *Is your eyesight (using glasses or corrective lenses as usual) excellent, very good, good, fair, or poor?* An additional response, registered blind, was included where respondents spontaneously provided this answer.

[Figure 1]

Each participant was also invited to a health assessment, either at a dedicated centre or in their home, in which objective measures of health were taken although VA was only assessed in health centres. During the health assessment, measured VA was taken using the logMAR chart (Minimal Angle of Resolution), an instrument preferred within a research setting (Grosvenor, 2007). The logMAR chart displays 5 letters per line, with regular spacing between lines and letters, uniform progression in letter size, and a fine grading scale allowing for greater accuracy and improved test-retest reliability (Bailey & Lovie-Kitchin, 2013). Respondents' achieved logMAR score is based on the total of all letters read (Figure 1). Each of the 5 letters on a line has a score of 0.02. Tested at 4 metres, reading all 5 letters on the top line gives a score of 1.0. Each line below will give a score 0.1 less than the line above. For example, were a respondent to read the 0.4 line in its entirety, they would receive a score of 0.4; were they to read the 0.4 line plus 3 letters from the line below (0.3 line), they would have a score of 0.34 (0.4 - (3 x 0.02)). LogMAR is more accurately a notation of *vision loss* since positive logMAR values indicate reduced vision, standard vision (20/20) equals 0 (i.e. no loss), and normal vision (better than 20/20) is indicated by negative logMAR value (Colenbrander, 2009). Respondents were allowed to wear corrective glasses or lenses for this test, therefore measurements are comparable with self-report assessments of vision and reflect corrected VA. Each eye was examined separately using a different chart to test each eye. Respondent's logMAR score from the better-seeing eye was used to indicate binocular VA as binocular VA can be closely predicted by the monocular acuity of the better-seeing eye (Rubin, Muñoz, Bandeen–Roche, & West, 2000) and therefore using the VA in the better-seeing eye is a standard approach (Congdon et al., 2004; Hsu, Cheng, Liu, Tsai, & Chou, 2004; Muñoz, West, & Rubin, 2000).

The ordinal self-report indicator of vision and the continuous logMAR score of VA were both dichotomised to indicate the presence of visual impairment. Self-reports of excellent, very good, or good vision were coded as normal vision while responses of fair vision, poor vision, or blindness were coded as visual impairment. Based on the ICD-9-CM ranges of VA, logMAR scores of 0.5 or lower (normal vision or mild vision loss) were coded as normal vision and scores greater than 0.5 (moderate, severe, and profound vision loss or near-blindness) were coded as visual impairment (Colenbrander, 2002).

Exclusionary criteria

There were 8504 respondents in the initial TILDA sample. For this study, respondents were excluded if they were under the age of 50 (N=329) or their age was not known (N=12). As measured VA was taken as part of the health assessment conducted at the health centre, respondents were excluded if they did not participate in the health assessment (N=2275), if they had the home-based assessment, in which VA was not tested (N=859), or VA was not measured in either eye during the health assessment (N=22). Those with more education, people in better health, and those in the youngest age groups were more likely to complete the health assessment (Savva, 2011); therefore, a 'health assessment' weight is used so that results based on these measures can be applied to the population. Finally, 109 respondents completed the VA test in only one rather than both eyes; these respondents were retained in the sample and their logMAR score from the examined eye was taken as their corrected VA. The analysis was conducted with the matched subjective-measured vision information from 5007 respondents aged 50 and over (Table 1).

Assessment of covariates

Demographic variables included age (grouped in 5-year bands so that non-linear effects could be examined) and gender. Gross asset wealth (quintiles) was also included in models. TILDA financial respondents were asked to describe their household's financial and non-financial assets; this total value is assigned to each member of the household. Approximately half of the sample did not respond fully to questions concerning their financial assets despite techniques to reduce question non-response, such as using unfolding brackets to allow a banded answer rather than a point estimate (O'Sullivan, Nolan, & Barrett, 2013; Savva, 2011). Respondents with missing financial data were retained in the sample and a 'missing' wealth category was created.

Models were also adjusted for the effects eye-related medical factors including having an eye condition (did not report a condition; reported cataracts, glaucoma, age-related macular degeneration, or diabetic retinopathy) and having received cataract treatment (no cataract surgery; had undergone cataract surgery). These factors may have an effect both on measured vision and on respondents' perception of their vision; an eye condition may reduce vision if diagnosis and treatment were not expeditious while undergoing cataract removal will likely improve vision if not complicated by the onset of another eye disease (Asbell et al., 2005; El Mallah et al., 2001; The Royal College of Ophthamologists, 2010). Finally, TILDA contains information on whether the respondent was a glasses wearer and whether glasses were worn during the test; it is unclear from the data whether glasses were needed for reading or for distance vision and it is not known why glasses were not worn during the test (e.g. inappropriate for the task or did not bring them to the health centre). Rather than exclude respondents from the sample, the effects of these variables were controlled for my entering a categorical variable into the model (does not wear glasses, wears glasses but not worn during test, wears glasses and worn during test, wears glasses but not known if worn during test).

Data analysis

First, self-reported visual impairment and measured low VA were cross-tabulated by demographic and health variables to provide an indication of the prevalence and social patterning of vision impairment; logistic regression was then applied in order to identify the factors that predict visual impairment, while holding constant the effects of all other varaibles in the model. Separate models were fitted for self-reported visual impairment and low VA. The health assessment weight was applied to this and all subsequent analyses.

[Figure 2]

Second, all responses were classified as either a true positive self-report (measured low VA and self-report visual impairment), a true negative (measured normal VA and self-report normal vision), a false positive (measured normal VA and self-report visual impairment), or false negatives (measured low VA and self-report normal vision). Using this information, diagnostic test statistics were calculated (Figure 2). To indicate the accuracy of the self-report measure in correctly identifying normal and low VA, the sensitivity and specificity of the self-reported vision were calculated. Sensitivity is the proportion of true positives that are correctly identified by the self-report question (that is, the probability of respondents self-reporting visual impairment when they also have measured low VA); alongside this the false positive fraction was calculated to quantify the error in the self-report assessment. Specificity is the proportion of true negatives correctly identified (that is, the probability of respondents self-reported normal vision when they also measure as having normal VA); the false negative fraction was also calculated (Altman & Bland, 1994a). To quantify the probability that self-reported vision would correctly indicate an underlying condition, predictive values were calculated. Positive predictive value (PPV) is the proportion of respondents self-reported visual impairment who are correctly identified; Negative predictive value (NPV) is the proportion of patients reporting normal vision who are correctly identified (Altman & Bland, 1994b).

Third, the categorical variable indicating true and false, positives and negatives was entered as the dependent variable in a multinomial logistic regression model, to identify the variables having a significant effect on (mis)reporting of visual impairment. The output was transformed into predicted probabilities to ease interpretation of the model; where significance is referenced in the findings, this relates to the original output expressed in log odds.

RESULTS

[Table 1]

Visual impairment, measured as logMAR>0.5 and subjectively as self-reported fair vision or worse, appears to be unevenly experienced across the population (Table 1). Visual impairment (both subjective and measured assessments) is more prevalent in women than men, at older ages, and in the lower wealth quintiles.

Table 1 suggests that respondents with an eye condition and those having undergone cataract surgery were more likely to self-report visual impairment compared with those with no eye condition or treatment (21.03% compared to 6.96%, and 14.83% compared to 8.73%, both statistically significantly different); however, according to measured VA, having an eye condition and having received treatment do not distinguish those with and those without low VA (4.70% compared with 3.26%, and 3.96% compared with 3.44%, neither were statistically significantly different). This suggests that having an eye condition and having received treatment for cataracts has a strong influence on respondents' *perception* of the quality of their eyesight when these factors are not good discriminators of those with normal VA and low VA.

Non-glasses wearers appear marginally more likely to self-report visual impairment compared to glasses wearers (9.78% compared with 8.64%, although not statistically significantly different). By comparison, non-glasses wearers appear more likely to present low VA than glasses wearers who wore corrective lenses during the vision assessment (3.18% compared with 1.21%, although not statistically significantly different) but less much less likely to present low VA than glasses wearers who did not wear glasses during the assessment (3.18% compared to 12.34%, which was statistically significantly different).

[Table 2]

Logistic regression models of the incidence of visual impairment showed self-reported visual impairment was not related to age (Table 2, m1). It was, however, significantly associated with level of wealth; holding all else constant, the middle, second, and lowest wealth quintiles were more likely to self-report visual impairment compared with the highest quintile (2.075**, 3.286***, 2.076**). Self-reported visual impairment was also related to wearing glasses (0.766*) and to having an eye condition (4.416***). Whereas crosstabulations suggested that having cataract surgery was associated with an increased probability of self-reported visual impairment, having controlled for the effects of other variables using regression modelling, having undergone cataract surgery was negatively associated with visual impairment (0.471**).

By comparison, low VA, as measured using the logMAR scale, was associated with gender, age, wearing glasses, and wealth (Table 2, m2). Holding all else constant, women were more likely to present low VA (1.818**). Increasing age was associated with increased probability of presenting low VA, with those aged 60 and over being significantly more likely to present with visual impairment. Being in the second and lowest wealth quintile was significantly related to low VA compared with the highest quintile (2.305* and 4.724***), having controlled for the effects of all other variables. As suggested by unadjusted data in Table 1, compared to those who do not usually wear glasses, wearing glasses and wearing them during the VA test was associated with a decreased probability of measuring with low VA (0.266***) while not wearing glasses during the test was associated with an increased probability of presenting low VA (3.913***). Having an eye condition and having received treatment for cataracts was not associated with measured low VA.

The introduction of the ordinal variable of self-reported vision (Table 2, m3) improved the overall fit of the model further (LR $chi^2(4)=11786.17$, $p<.000$) and explained a greater proportion of the variance in low VA (Pseudo $R^2 = 0.177$). Self-reported fair vision and reporting poor vision or blindness were associated with an increased probability of presenting low VA (4.021*** and 16.934***). Together this indicates that self-reported vision acts as a significant independent predictor of measured low VA in older people beyond socioeconomic and health variables.

[Table 3]

To evaluate the performance of the self-report assessment in correctly identifying those with and without low VA, the sensitivity and specificity of the self-reported visual impairment was calculated. Table 3 shows that if a respondent had low VA, there was a 25.1% probability that they would self-report visual impairment (sensitivity); however, there was an 8.5% probability that respondents would self-report visual impairment but have normal VA (false positive fraction, or 1-specificity). This indicates that only 1 in 4 people with low VA will self-report visual impairment, while roughly 1 in every 12 people with normal VA will also self-report visual impairment. Conversely, if a respondent had normal VA, there was a 91.5% probability that they would self-report normal vision (specificity); while if a respondent had low VA there was a 74.9% probability that they would self-report normal vision and therefore not identify an underlying condition (false negative fraction, or 1-sensitivity). This indicates that 11 out of 12 people with normal VA will self-report normal vision, while 3 in every 4 respondents with low VA will also self-report normal vision.

While sensitivity and specificity indicate the likeliness that measured VA is correctly identified by self-reported vision, predicted values indicate the likelihood that self-reported vision correctly identifies measured VA. If a respondent self-reported visual impairment, there was a 9.6% probability that they would measure with low VA (PPV), suggesting that there were a large proportion of people who felt their vision was impaired when it did not measure as such. If a respondent self-reported normal vision, there was a 97.1% probability that they would measure with normal VA (NPV), suggesting that for those who perceived their vision to be normal, they were likely to be correct in their assessment.

PPV and NPV are intrinsic to the self-report assessment, but depend also on the prevalence of measured low VA in the population. As seen in Table 1, the prevalence of low VA differs by gender, age, and wealth. Prevalence within a sub-group can be interpreted as the probability of reporting visual impairment before a response is given to self-reported vision. The rarer low VA is (e.g. in the youngest and the wealthiest quintiles) the more certain it is that a self-report of normal vision will indicate normal VA. So as the prevalence of low VA varies between subgroups in the population (Tables 1 and 3), the probability that the self-reported visual impairment correctly identifies measured low VA also varies.

[Table 4]

Modelling the (mis)reporting of visual impairment formally using multinomial logistic regression indicated that a number of variables had a significant effect on the accuracy of the self-reported assessment, including age, wealth, and having an eye condition (Table 4). Holding all else constant, as age increased so the probability of providing a true negative decreased (self-reported normal vision and measuring with normal VA) and the probability of false negative reporting increased (self-reported normal vision and measuring with low VA).

Level of wealth was also associated with (mis)reporting of visual impairment. Compared with the highest wealth quintile, the middle wealth quintile were less likely to correctly self-report normal vision (TN=-6.4%) and instead were more likely to self-report visual impairment when they measured as having normal VA (FP=5.4%). The second wealth quintile were even less likely to correctly self-report normal vision (TN=-12.7%) and again tended to incorrectly self-report visual impairment (FP=10.7%) but also incorrectly self-report normal vision (FN=1.3%). Finally, compared to the highest wealth quintile, the lowest wealth quintile were less likely to correctly self-report normal vision (TN=7.7%) and were more likely to incorrectly self-report visual impairment (FP=2.7%), incorrectly self-report normal vision (FN=2.6%), but also more likely to correctly self-report visual impairment (TP=2.4%).

Holding all else constant, having an eye condition decreased the probability of a true negative response by 14.9% and increased the probability of a false positive by 14.2%; thus, respondents with eye conditions were less likely to correctly self-report normal vision and instead were more likely to self-report visual impairment when they measured as having normal VA.

DISCUSSION

Findings show that subjective and measured assessments of visual impairment are significantly related and that perceived vision is a significant predictor of measured low VA in older people, independent of socioeconomic and health variables (Table 2). Almost all of those classified as normal vision according to VA measures were correctly identified by the self-report indicator; 11 in 12 people with normal VA correctly self-reported normal vision (91.5% specificity) and almost all of those who self-reported normal vision measured with normal VA (97.1% NPV) (Table 3). Good vision is therefore well captured by a subjective response. However, visual impairment is slightly over included. Almost 1 in 12 people with normal VA self-reported visual impairment (8.5% false positive fraction) while 3 in 4 of those who self-reported visual impairment then measured with normal VA (74.9% false negative fraction). 1 in 4 people with measured low VA self-reported visual impairment (25.1% sensitivity) and 1 in 12 people who self-reported visual impairment measured with low VA (PPV 9.6%). The over inclusion of those with good measured visual acuity in a poor vision category using a subjective indicator of visual function may mean models predicting self-reported visual impairment will be lower on precision and underestimate the size of effects.

It was somewhat interesting that age was not a strong predictor of self-reported vision in the adjusted models given the strong evidence of the deterioration of vision with age, including the increasing probability of measuring with low VA with an increase in age, shown in this study. One explanation is that it is unclear what frame of reference people are using when responding to the self-report question on vision: are they rating their vision compared to what it used to be (in which case one would expect to find an age-gradient) or compared to their peers (in which case the effects of age may become less pronounced). Alternatively, it has been argued that older adults adopt coping strategies in a process of adapting to changes in vision, which may have an effect on the perceived severity of vision loss (Brennan & Cardinali, 2000). Alternatively, it may be a straightforward example of socially desirable responding wherein self-reported vision is affected by respondents' unwillingness to associate their health status with the ageing process.

A number of factors were found to have a significant influence on the accuracy of respondents' self-reported vision. The accuracy of perceived vision varied by level of wealth: the sensitivity of the self-report indicator increased with a decrease in wealth (Table 3). Multinomial logistic regression showed that the poorest were more likely to report true positives, compared with the highest wealth quintile (Table 4). Diagnostic statistics of the accuracy of the self-report indicator are partly related to the higher prevalence of measured visual impairment in the poorest quintile (7.6% compared with 1.7% of the highest quintile) (Tables 1 and 3). Nevertheless, the analysis supports findings of the differences between the wealthiest and the poorest wealth quintile, highlighting significant health inequalities experienced by older people. Rather than social position being related to vision per se, what this finding may indicate is that social inequality has an effect on the identification and treatment of refractive errors and eye disease and therefore on vision.

Having an eye condition also had a strong influence on respondents' self-reported eyesight but this factor was not a good discriminator of those with normal VA and low VA. The difference in the prevalence of measured low VA between those with and without an eye condition was small (4.70% and 3.26%), but those with an eye condition were more likely to self-report visual impairment (21.03% compared with 6.96%). Given that the presenting symptoms[1] of the four most common eye diseases in older people[2], it is possible that a test of VA alone was insufficient to detect visual impairment.

---

[1] Blurred vision, image distortion, loss of central vision, visual field loss, sensitivity to light and glare, seeing 'halos' around lights, cloudy or misty vision, double vision, floaters, and poor night vision.
[2] Age-related macular degeneration, glaucoma, diabetic retinopathy, and cataracts.

Measured VA was assessed using glasses or corrective lenses as usual; however, it is not known whether respondents' glasses were of optimum strength and consequently whether their measured VA reflects their best corrected vision. If the prescription in the glasses or lenses worn during the test was dated and an incorrect strength, measured VA would be lower than what the respondent was capable of achieving. As a result, it is likely that the number of respondents measuring with low VA is greater than if respondents' glasses were of optimum strength. However, both self-reported vision and measured VA were examined under the same conditions (i.e. using glasses or corrective lenses *as usual*). Therefore it is also likely that not wearing the current and correct prescription will also have an effect on respondents' self-reported vision. Therefore while it is worth noting, the focus of the study is the relationship between the measures and not an estimate of rates of visual impairment in the population, which remains unchallenged by this limitation in the data collection.

While the logMAR test may be a good instrument for testing VA within a research setting, testing VA alone may be an oversimplification of older adults' visual function in daily life. Many older people with normal acuity are effectively visually impaired in performing everyday tasks under non-ideal conditions involving low and changing light levels, glare, and low contrast, therefore routine measures of VA may be insufficient for detecting visual impairment (Brabyn, Schneck, Haegerstrom-Portnoy, & Lott, 2001; Haegerstrom-Portnoy, Schneck, & Brabyn, 1999). Rather than the over inclusion of poor vision being the result of inaccurate self-reporting, the subjective assessment may be a more accurate indicator of visual functioning as it represents a cognitive averaging of visual function under different conditions encountered in daily life, beyond high contrast letter recognition under optimal lighting conditions. In this sense it may be questioned whether these two measures should be considered complimentary, but do not necessarily capture the same construct, offering some explanation of the seeming over identification and mis-reporting of visual impairment. Self-reported vision is therefore found to be a strong measure of good vision in older people; the slight over-identification of visual impairment using a self-reported vision may indicate visual impairment beyond that measured by tests of visual acuity alone. Given the simplicity of the self-report assessment to administer and the correspondence between this and measured VA, it is argued to be a suitable indicator of visual impairment in older people.

REFERENCES

Altman, D., & Bland, J. (1994a). Statistics Notes: Diagnostic tests 1: sensitivity and specificity. *Bmj, 308*(6943), 1552. doi: 10.1136/bmj.308.6943.1552

Altman, D., & Bland, J. (1994b). Statistics Notes: Diagnostic tests 2: predictive values. *Bmj, 309*(6947), 102. doi: 10.1136/bmj.309.6947.102

Asbell, P., Dualan, I., Mindel, J., Brocks, D., Ahmad, M., & Epstein, S. (2005). Age-related cataract. *The Lancet, 365*(9459), 599-609.

Bailey, I., & Lovie-Kitchin, J. (2013). Visual acuity testing. From the laboratory to the clinic. *Vision Research, 90*(0), 2-9. doi: http://dx.doi.org/10.1016/j.visres.2013.05.004

Brabyn, J., Schneck, M., Haegerstrom-Portnoy, G., & Lott, L. (2001). The Smith-Kettlewell Institute (SKI) longitudinal study of vision function and its impact among the elderly: an overview. *Optometry & Vision Science, 78*(5), 264-269. doi: 10.1097/00006324-200105000-00008

Brennan, M., & Cardinali, G. (2000). The Use of Preexisting and Novel Coping Strategies in Adapting to Age-Related Vision Loss. *The Gerontologist, 40*(3), 327-334. doi: 10.1093/geront/40.3.327

Colenbrander, A. (2002). *Visual Standards: Aspects and Ranges of Vision Loss with Emphasis on Population Surveys*. Paper presented at the 29th International Congress of Ophthalmology, Sydney, Australia. http://www.icoph.org/downloads/visualstandardsreport.pdf

Colenbrander, A. (2009). Measuring vision and vision loss. In E. Jaeger & W. Tasman (Eds.), Duane's Ophthalmology (15th ed.). Philadelphia, PA: Lippincott Williams and Wilkins.

Congdon, N., O'Colmain, B., Klaver, C., Klein, R., Munoz, B., Friedman, D., . . . Mitchell, P. (2004). Causes and prevalence of visual impairment among adults in the United States. *Archives of ophthalmology, 122*(4), 477-485.

El Mallah, M., Hart, P., McClure, M., Stevenson, M., Silvestri, G., White, S., & Chakravarthy, U. (2001). Improvements in measures of vision and self-reported visual function after cataract extraction in patients with late-stage age-related maculopathy. *Optometry & Vision Science, 78*(9), 683-688. doi: 10.1097/00006324-200109000-00014

Grosvenor, T. (2007). *Primary Care Optometry* (5th ed.). St Louis, Missouri: Butterworth-Heinemann Elsevier.

Grundy, E., & Holt, G. (2001). The socioeconomic status of older adults: How should we measure it in studies of health inequalities? *Journal of Epidemiology and Community Health, 55*(12), 895-904. doi: 10.1136/jech.55.12.895

Grundy, E., & Sloggett, A. (2003). Health inequalities in the older population: the role of personal capital, social resources and socio-economic circumstances. *Social science & medicine, 56*(5), 935-947. doi: http://dx.doi.org/10.1016/S0277-9536(02)00093-X

Haegerstrom-Portnoy, G., Schneck, M., & Brabyn, J. (1999). Seeing into old age: vision function beyond acuity. *Optometry and Vision Science, 76*, 141-158. doi: 10.1097/00006324-199903000-00014

Hsu, W., Cheng, C., Liu, J., Tsai, S., & Chou, P. (2004). Prevalence and causes of visual impairment in an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Ophthalmology, 111*(1), 62-69.

International Federation on Ageing. (2013). The High Cost of Low Vision: The Evidence on Ageing and the Loss of Sight. New York.

Muñoz, B., West, S., & Rubin, G. (2000). Causes of blindness and visual impairment in a population of older americans: The salisbury eye evaluation study. *Archives of ophthalmology, 118*(6), 819-825. doi: 10.1001/archopht.118.6.819

O'Sullivan, V., Nolan, B., & Barrett, A. (2013). Income and Wealth in the Irish Longitudinal Study on Ageing *IZA Discussion Paper*. Bonn, Germany: Institute for the Study of Labor (IZA).

Razavi, T. (2001). *Self-report measures: An overview of concerns and limitations of questionnaire use in occupational stress research*. Discussion Paper. University of Southampton. Southampton, UK. Retrieved from http://eprints.soton.ac.uk/35712/

Rubin, G., Muñoz, B., Bandeen–Roche, K., & West, S. (2000). Monocular versus Binocular Visual Acuity as Measures of Vision Impairment and Predictors of Visual Disability. *Investigative Ophthalmology & Visual Science, 41*(11), 3327-3334.

Savva, G. (2011). Methodology. In A. Barrett, G. Savva, V. Timonen & R. Kenny (Eds.), *Fifty Plus in Ireland 2011: First results from the Irish Longitudinal Study on Ageing (TILDA)*. Dublin.

The Royal College of Ophthamologists. (2010). Cataract Surgery Guidelines.

Zimdars, A., Nazroo, J., & Gjonça, E. (2012). The circumstances of older people in England with self-reported visual impairment: A secondary analysis of the English Longitudinal Study of Ageing (ELSA). *British Journal of Visual Impairment, 30*(1), 22-30. doi: 10.1177/0264619611427374

TABLES

Table 1 Sample characteristics and prevalence of visual impairment

	Baseline/total		**Low visual acuity (logMAR)**		**Visual impairment (self-report)**	
	N	% weighted	N	% (row) weighted	N	% (row) weighted
Gender						
Male	2,297	49.1	59	2.63	186	8.87
Female	2,710	50.9	102	4.28	213	9.22
Age group						
50 - 54	1,121	21.8	20	1.74	87	8.49
55 - 59	1,133	22.9	22	2.14	79	7.58
60 - 64	954	20.0	31	3.37	69	7.93
65 - 69	797	14.3	36	4.44	68	9.08
70 - 74	1,002	20.9	52	6.16	96	12.30
Wealth						
Highest	637	10.7	11	1.69	34	5.46
Fourth	590	10.8	17	2.78	24	4.52
Middle	541	11.4	16	2.96	51	10.41
Second	407	9.4	18	4.30	57	16.08
Lowest	371	8.4	25	7.58	37	10.75
Missing	2461	49.2	74	3.26	196	8.88
Eye condition						
No condition	4,283	85.2	129	3.26	261	6.96
Has eye condition	724	14.8	32	4.70	138	21.03
Cataract surgery						
No treatment	4,768	94.7	152	3.44	366	8.73
Received treatment	239	5.3	9	3.96	33	14.83
Glasses						
No glasses	1,781	36.2	52	3.18	152	9.78
Glasses	3,117	63.8	109	3.63	247	8.64
- *not worn during test*	*566*	*11.6*	*69*	*12.34*		
- *worn during test*	*1,776*	*34.2*	*18*	*1.21*		
- *missing*	*884*	*18.0*	*22*	*2.64*		

Table 2 Logistic regression of low visual function, odds ratio

	m1 **Self-reported**	m2 **Low VA**	m3 **Low VA**
Sex			
Male			
Female	0.925	1.818**	1.972***
Age			
50 - 54 yrs			
55 - 59 yrs	0.876	1.091	1.152
60 - 64 yrs	0.877	1.862*	2.064*
65 - 69 yrs	0.902	2.897***	3.175***
70 yrs and over	1.093	4.217***	4.487***
Glasses			
No glasses			
Usually wears glasses/lenses	0.766*		
- not worn for VA test		3.913***	4.316***
- worn for VA test		0.266***	0.253***
- other		0.763	0.856
Eye condition			
No			
Yes	4.416***	1.275	0.754
Cataract Surgery			
No			
Yes	0.471**	0.431	0.524
Wealth quintile			
Highest			
Fourth	0.797	1.664	1.694
Middle	2.075**	1.644	1.399
Second	3.286***	2.305*	1.879
Lowest	2.076**	4.724***	3.999***
Missing	1.709*	1.595	1.434
Self-reported vision (ordinal)			
Excellent			
Very Good			1.124
Good			1.650
Fair			4.021***
Poor or blind			16.934***
Constant	0.056	0.007	0.004
Pseudo R2	0.063	0.139	0.177

Table 3 Correspondence of subjectively assessed and measured visual function (weighted)

	Prevalence	Sensitivity %	Specificity %	ROC area	PPV %	NPV %
Total sample						
	3.470	25.1	91.5	0.583	9.6	97.1
Age						
50 – 54	1.744	44.5	92.1	0.683	9.1	98.9
55 – 59	2.142	29.7	92.9	0.613	8.4	98.4
60 – 64	3.367	15.6	92.3	0.540	6.6	96.9
65 – 69	4.438	19.1	91.4	0.552	9.3	96.0
70 +	6.162	25.5	88.6	0.570	12.8	94.8
Wealth						
Highest	1.688	21.4	94.8	0.581	6.6	98.6
Second	2.784	22.1	96.0	0.591	13.6	97.7
Middle	2.960	32.3	90.3	0.613	9.2	97.8
Fourth	4.304	29.8	84.5	0.572	8.0	96.4
Lowest	7.580	37.0	91.4	0.642	26.1	94.7
Glasses						
No glasses	3.181	27.4	90.8	0.591	8.9	97.4
Glasses: not worn in test	12.338	21.0	93.3	0.571	30.6	89.3
Glasses worn in test	1.212	43.1	90.4	0.668	5.2	99.2
Other	2.641	16.0	94.1	0.550	6.8	97.6

Table 4 Predictors of misreporting (predicted probabilities)

		True +ve	True -ve	False +ve	False -ve
Sex					
	Female	0.000	-0.004	-0.006	0.010
Age					
	55 - 59 yrs	-0.001	0.004	-0.007	0.004
	60 - 64 yrs	-0.002	-0.009	-0.007	0.019
	65 - 69 yrs	0.000	-0.025	-0.008	0.034
	70 yrs and over	0.001	-0.052	0.002	0.048
Glasses					
	Glasses: not worn for test	0.008	-0.013	-0.028	0.033
	Glasses: worn for test	-0.003	0.027	-0.006	-0.018
	Glasses: unknown	-0.003	0.033	-0.028	-0.002
Eye condition					
	Yes	0.013	-0.153	0.143	-0.004
Cataract Surgery					
	Yes	-0.001	0.051	-0.039	-0.011
Wealth quintile					
	Fourth	0.003	0.006	-0.017	0.008
	Middle	0.006	-0.068	0.058	0.005
	Second	0.008	-0.138	0.117	0.013
	Lowest	0.027	-0.093	0.038	0.029
	Missing	0.001	-0.044	0.036	0.007
Constant		0.005	0.913	0.069	0.013

FIGURES

Figure 1 LogMAR score formula

LogMAR score = 0.1 + logMAR value of the best line read – (0.02 x number of letters read)

Figure 2 Fundamental numbers and ratios of the relationship between subjectively assessed and measured vision

<table>
<tr><td></td><td></td><th colspan="2">Measured visual acuity (logMAR)</th><td></td></tr>
<tr><td></td><td></td><td>Condition positive
(visual impairment)</td><td>Condition negative
((near) normal vision)</td><td></td></tr>
<tr><th rowspan="2">Subjective measure</th><td>Self-report positive
(report visual impairment)</td><td>True positive rate
(TP)</td><td>False positive rate
(FN)</td><td>Positive predictive value
Pr(A|+)
=TP/(TP+FP)</td></tr>
<tr><td>Self-report negative
(report normal vision)</td><td>False negative rate
(FN)</td><td>True negative rate
(TN)</td><td>Negative predictive value
Pr(N|-)
=TN/FN+TN</td></tr>
<tr><td></td><td></td><td>Sensitivity
Pr(+|A)
=TP/(TP+FN)</td><td>Specificity
Pr(-|N)
=(TN/(FP+TN)</td><td></td></tr>
</table>